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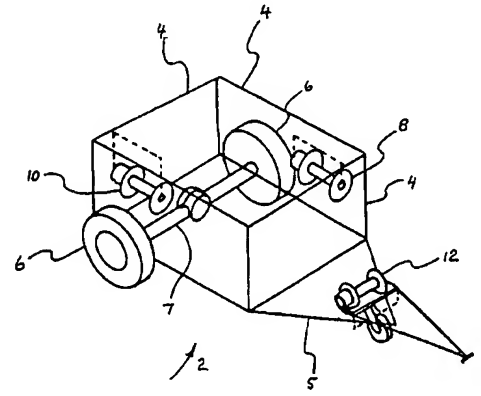

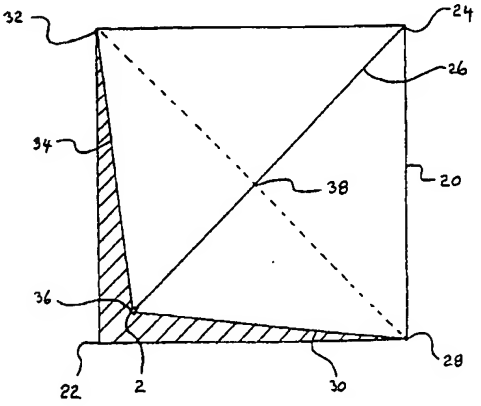

(57) Abstract: A method for allowing access by livestock to fresh feed in a fenced enclosure (20) comprising partitioning the enclosure (20) by an electric fence assembly (30, 34, 38) so that the livestock may graze in a first portion (hatched) of the enclosure (20) but are excluded from a second portion containing said fresh feed, and causing the fence assembly (30, 34, 38) to move so that it advances across said second portion of the enclosure (20) to expose more feed to the livestock. A self-propelling trailer type carriage device (2) to perform the method is described.

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CONSTRUCTION AND OPERATION OF A TRAVELLING ELECTRIC FENCE

Background and Summary of the Invention

This invention concerns the use of temporary electric fencing to confine grazing animals to only part of a paddock so the grass or other feed growing, or dry feed laid out, in the remainder of the paddock is not immediately available to the animals. This can be important for feed conservation by way of protecting feed from trampling and animal faeces before the animals have the opportunity to eat it, and is also useful in controlling bloat and similar conditions brought on by an excess of fresh green feed.

The use of temporary electric fences to exclude grazing animals from parts of paddocks is well known to farmers. In one form of use, a single line of electric fencing is strung across a paddock on posts to divide it into grazed and non-grazed areas. The fence may be moved from time to time by repositioning the posts. A more sophisticated use is that known as strip grazing. This procedure involves running a pair of electric fences across a paddock with a gap of, for example, 50 to 200 metres between the fences. The grazing animals are constrained to the strip of ground lying between the pair of electric fences. The fences are periodically moved by repositioning the posts in order to move the grazed strip along the paddock. With appropriate spacing of sufficient water supply points in the paddock, this can give the advantage of fully resting every area of the paddock between periods of intensive grazing. It also provides a way to limit access of the animals to fresh feed at times when the intake of such feed should be limited because of the likelihood of bloat.

The maximum benefit is obtained from frequent small movements of the temporary electric fencing. But the movement of such fencing is a labour intensive activity. Posts need to be pulled up and hammered into new positions, and conductor wire or

tape restrung. Therefore in practice the movements are made much less frequently and expose larger areas of new feed than would be preferred.

An aim of the present invention is to provide an apparatus and method which allows an electric fence assembly to move automatically under its own propulsion across a paddock to slowly expose fresh feed to the animals. The feed is protected from trampling and fouling before it is eaten. Also, the animal's consumption of fresh feed may be limited and thus the incidence of bloat controlled.

Accordingly, in one aspect the invention provides an electric fence assembly comprising:

(i) a carriage means which moves across the ground inside a fenced enclosure;

(ii) an electrically conducting element extending from the carriage means to an anchorage point at a fence of the enclosure;

(iii) means for supporting the conducting element above the ground between the carriage means and the anchorage point;

(iv) means for maintaining the conducting element at a voltage suitable for an electric fence; and

(v) means for propelling the carriage means across the ground.

Preferably the propulsion means comprises a motor powered winch mounted on the carriage means and the winch engages a cable. Preferably the propulsion means further includes a cable fully windable onto a drum of the winch. The carriage means may include a steerable wheel which engages the ground to steer the carriage means, and a steering mechanism which engages the cable and points the steerable wheel towards the destination

In another aspect the invention provides a method of allowing access by livestock to fresh feed in a fenced enclosure comprising:

(i) partitioning the enclosure by an electric fence assembly so that the livestock may graze in a first portion of the enclosure but are excluded from a second portion containing said fresh feed;

(ii) causing the fence assembly to move so that it advances across said second portion of the enclosure to expose more feed to the livestock.

Preferably the fence assembly moves under its own propulsion.

In a further aspect the invention provides a support for an electric fence, said fence comprising a conducting element held above the ground at a height suitable for the relevant livestock, said support comprising a wheel having a circumferential rim with a diameter of twice the height at which the horizontal conducting element is held above the ground, and the conducting element passing through a hollow axis member of the wheel.

Within the definitions and descriptions of the present invention the term "cable" should be understood to encompass rope, wires and such similar flexible elongate materials suitable for imparting a suitable tensile force.

Brief Description of the Drawings

In order that the invention may be more fully understood there will now be described, by way of example only, preferred embodiments and other elements of the invention with reference to the accompanying drawings where:

Figure 1 is a schematic layout indicating the location of major components on a trailer used for one embodiment of the invention;

Figure 2 is a multiple-cutaway plan view of the trailer shown in Figure 1 showing a slightly different arrangement of components;

Figure 3 is a cutaway side elevation of the trailer shown in Figure 2;

Figure 4 is a plan view of a lower portion of the frame of the trailer shown in Figure 2;

Figure 5 is a side view of the frame of the trailer shown in Figure 2;

Figure 6 is a plan view of an upper portion of the frame of the trailer shown in Figure 2;

Figures 7 to 10 are plan views of paddocks in which the trailer in Figure 1 is being used;

Figure 11 is a detail showing the front part of the trailer in Figure 1;

Figure 12 is a perspective view of part of an electric fence utilising the present invention;

Figure 13 is a side view of one of the supports used for the electric fence shown in Figure 12;

Figure 14 is an isometric detail of part of a support of the type shown in Figure 13 although with some differences in detail;

Figure 15 is a simplified cutaway front view of a trailer of the type shown in Figure 2;

Figure 16 is an enlarged detail view of part of Figure 15;

Figure 17 shows an alternative configuration to that shown in Figure 16;

Figure 18 is a side view of components on the trailer shown in Figure 2;

Figures 19 and 20 are views along line X-X shown on Figure 18 showing different configurations being adopted;

Figure 21 is a view along line Y-Y shown in Figure 18;

Figure 22 is a plan view of part of the trailer shown in Figure 11;

Figure 23 is a partial cutaway side view of the assembly shown in Figure 22;

Figure 24 is an end view of the right hand portion of Figure 22; and

Figure 25 is a plan view of a paddock in which another embodiment of the invention is being used.

Detailed Description of Embodiments

Referring to Figures 1 to 6, a trailer 2 has a perimeter box frame 4 welded from suitable steel section. In schematic Figure 1, for clarity the trailer frame 4 is shown as a simple wire-frame type of construction. However its components are shown more realistically in Figures 2 to 6.

The frame 4 has an approximately square base portion 72 and square top portion 73 joined by corner uprights 74. Extending between the top 73 and base 72 are two pairs

of vertical sub-frame members 75 offset from each other on either side of the frame. For a frame of 1 metre square, 50mm x 50mm angle section has been found suitable for the perimeter of the base 72, top 73 and uprights 74. The top portion 73 of the frame carries horizontal sub-frame members 76 and 77 which form a lattice 78 having a central hole 79 of approximately 240mm square. The function of the vertical members 75 and lattice 78 will be described later in this specification. The sub-frame members 76 are conveniently 50mm x 6.5mm flat steel and the members 77 are 35mm square hollow tube.

The frame 4 is bolted to an axle 7 onto which is mounted a pair of wheels 6 which preferably carry automobile type tyres. The axle may be of simple tubular construction as used on light duty automobile trailers, but may alternatively comprise a differential 14 recycled from an automobile as shown in Figures 1 and 2. A short A-frame draw bar 5 is rigidly connected to the base of the main portion of the trailer frame.

Mounted from the frame 4 are three winch assemblies 8, 10 and 12 each comprising a winch drum 17 and a close coupled axially-in-line electric motor 18 to power the drum. In use, a thin wire rope or cable 19 suitable as an electric fence conductor is wound onto winches 8 and 10 while a traction cable 26 is wound onto the traction winch 12. For each of the conductors 19 and the traction cable a 4mm diameter galvanised steel wire rope approximately 250 metres long has been found to be suitable. Conductor winch assemblies 8 and 10 are pivotally mounted from the frame 4 and traction winch assembly 12 is rotatably moveable relative to the frame 4. Details of their motion will be described later.

The trailer carries a lead acid battery (not shown) of about 40ah capacity to power the winches. The power supply for the conventional pulsing voltage in the active conductor cables 19 may be carried on the trailer, but is preferably accessed by tapping onto an external supply as described below.

With reference to Figure 7, to use the electric fence assembly, the trailer 2 is placed in a paddock near one corner, with the A-frame 5 pointed towards the diagonally opposite corner. Clutches on the three winches are released to free the drums and the traction cable 26 is run out and securely anchored at a paddock corner 24. Conductor cable 30 is run out from winch 8 and attached securely to the fence post at corner 28 of the paddock. If the fence electrification voltage is being drawn from a fixed source on the fence a flexible electrical coupling is made between the fixed source and the conductor cable 30. The winch 8 is then actuated to tension the cable 30. This step is replicated as conductor cable 34 is run out from winch 10 and attached as appropriate to the fence post at corner 32 of the paddock. The winch 10 is then actuated to tension the cable 34.

Although winch 8 is on the left hand side of the trailer, its cable extends across the trailer and out the right hand side to be connected at the fence on the right hand side. Similarly for winch 10, which is on the right hand side of the trailer, its cable extends across the trailer and out the left hand side to be connected at the fence on the left hand side. Having the cables pass across the trailer allows more even laying of the cables onto the drums and also provides space for a cable tension control system for each winch. These aspects will be described in more detail later in this specification.

The traction winch 12 is then engaged, which pulls the trailer slowly across the paddock to corner 24. When the trailer starts moving forward, tension is automatically maintained in the conductor cables 30 and 34 by the conductor winches 8 and 10. As the trailer moves from its starting point 36 towards the centre 38 of the paddock, the winches 8 and 10 need to wind in conductor. However once the trailer has passed the centre 38 of the paddock, the winches 8 and 10 need to gradually release more cable. The manner by which this is achieved will be described later in this specification.

The rate at which the winch 12 winds in its cable, and thus propels the trailer, is steplessly variable by the operator. The traction winch 12 may be operated continuously at a low speed, but is preferably operated at a higher speed but

intermittently. Setting of the periods that the winch 12 is alternatively turning and stationary may be accomplished by fitting any one of many timer controls available in the marketplace. Preferably the period of activation in each activation-deactivation cycle is kept constant and the time between activations is varied.

It has been found that a useful guide is to activate the traction winch 12 sufficiently long to move the trailer in the range of 0.5 to 1.5 metres. Typically the trailer might be moved half a meter at 30 minute intervals, although it will be appreciated that this could be very different in practice due to different paddock sizes, stocking rates and amount of feed. Also, due to activation being controlled on a time basis, and the depth of cable on the winch drum varying as the trailer moves across the paddock, the linear measurement of advancement is only approximate and may vary significantly over a single paddock.

If it is found that the above rate of progress across the paddock is insufficient, then the period between the activations of the traction winch is preferably shortened, rather than the alternative of lengthening the period of activation. In order to minimise spoilage of the feed by grazing animals, it is better to expose narrower bands (say 0.5 to 1.5 metres wide) of fresh feed to the animals more frequently rather than expose broader bands less frequently.

Independently of each other, the winches 8 and 10 detect the tension in their respective conductor cables and automatically take up or let out their cable as appropriate. Examination of Figure 8 shows that when the trailer 2 is placed in a rectangular paddock at position 46, and the traction winch is engaged to pull the trailer towards a distant corner 48, initially both winches 8 and 10 need to wind in their respective cables as the trailer approaches point 43. At point 43 cable 34 has its minimum required length. While travelling between points 43 and 44, winch 8 continues to pull in cable 30 while winch 10 is feeding out cable 34. At point 44 cable 30 has its minimum required length and between point 44 and corner 48 both winches 8 and 10 feed out their cables.

Figures 9 and 10 illustrate an alternative method of using the present invention to graze the rectangular paddock shown in Figure 8. In Figure 9 the conductor cables 30 and 34 are attached to fence posts at positions 40 and 41 while the trailer is being drawn from position 46 to 47. When the trailer reaches 47 half the paddock is exposed for grazing. Then, without moving the conductor cable at 40, the conductor cable 34 is moved from 41 to corner 42 and the traction cable moved to corner 49. The trailer then moves along the path shown in Figure 10 to corner 49 at which point the paddock has been fully exposed to grazing. It will be readily seen how any elongate or irregularly shaped paddock can be grazed using this principle.

Referring to Figures 3 and 11, towards the front of the short A-frame 5 is a short vertically aligned axle 54 which is rotatably connected to a cross member 50. The traction winch 12 is mounted to a base plate 56 which is in turn centrally fixed to the top of the axle 54. At the bottom of the axle is a dolly wheel 52 of about 250mm diameter. This may have a castor action, as shown in Figure 11 or may not have a castor action as shown in Figure 3.

Referring to Figure 11, from each end of the base plate 56. an arm 58 and 60 extends forward a short distance to where they are pivotally connected at bearing pins 66 to a pair of shafts 62 and 64. The shafts are joined at their forward ends and at the leading tip a guide 70 is fitted through which the traction cable 26 is routed. By this means the shafts 62 and 64 remain pointed towards, and thus the wheel 52 is aligned towards, where the traction cable is anchored. Thus the trailer efficiently steers itself towards its intended target.

A towing hitch point 51 is affixed to the front of the short A-frame 5 in order to tow the trailer behind a vehicle. The towing hitch point 51 is set low in order to provide maximum ground clearance for the dolly wheel 52 when under tow. The trailer is easily towable by a car on the road or by a small tractor or 4-wheel "agbike".

A major difficulty with arranging any type of electric fence to move by itself across a paddock is arranging for the electric conductor wire to maintain the required distance

above the ground. This distance is different for different animal species. Even if substantial tension is maintained in the wire or cable, catenary effects and undulations in the paddock mean that it still must be supported about every 25 metres.

Figure 12 is a perspective view of portion of the electric fence in Figure 7 and illustrates how in one aspect the present invention overcomes such a difficulty. The conductor cable 30 is shown extending towards the side corner 28 of the paddock. The trailer is out of view just to the left. The cable 30 is supported above the ground by a series of wheels 81, 82, 83 and 84 in accordance with one embodiment of the present invention. The construction of each wheel will now be described with reference to Figures 13 and 14. The dimensions given are those suitable for grazing dairy cattle, but suitable dimensions may be readily chosen to suit the type of livestock concerned.

Referring to Figure 12, the wheels 81, 82 and 83 are identical but wheel 80 is slightly different to them at its centre. Figure 13 illustrates their general construction. The wheels 80 to 83 as shown in Figures 12 and 13 all have six spokes. However a more preferred configuration is for them to have eight spokes which provides greater rigidity and control of the perimeter's shape. The wheel 84 shown in Figure 14 has eight spokes, but is otherwise the same as six-spoked wheel 80. Due to the commonality of design elements, Figures 13 and 14 will be referred to when explaining the structure of both types of wheel.

The wheels are approximately 1.5 metres diameter and have an outer rim 86 which may be conveniently made from low cost flexible PVC irrigation tubing of about 20mm diameter. The six or eight identical spokes 88 are conveniently made from 16mm diameter aluminium tubing. The inward end of the spokes are each attached by rivets or bolts 91 to a hub 90 made from two discs 92 of aluminium sheet. Through the axis of the hub passes a 20mm diameter steel tube 94 which protrudes about 0.7m from each face of the hub. In using the electric fence, the electric conductor cable passes through the tube 94 in order to support the cable the desired distance above the ground, that is half the diameter of the wheel.

The relatively large diameter of the wheels and their continuous rim 86 means they ride easily over relatively rough ground.

Each wheel is constructed so as to be easily placed onto the centre of a cable after the cable ends are already fixed to the trailer and a fence respectively. The axial tube 94 has a slit 96 running the full length of its wall and the slit is wide enough to easily slip the conductor cable 30 through it. At each end of the tube the slit is cut as a dogleg such that there is a short section 98 of the slit which is offset around the circumference of the tube by about twice the width of the slit and which is connected to the rest of the slit 96 by a short circumferential section 99 of the slit. As a result of the doglegged slit, when the cable 30 is tensioned through the tube, the cable cannot slip out of the slit. The hub discs 92 have slits 102 which connect with the tube slit 96 to allow the cable to slip into and out of the tube when assembling and dismantling the electric fence configuration.

Each of the spokes 88 has an electrically insulating segment 89 inserted into it and held firmly about three quarters of the way from the hub 90 to the rim 86. In this way the conductor cable 30 remains insulated from the ground. The insulating segment 89 may be a collared double-ended plug or even a conventional connector for PVC tubing.

Relative to wheels 81, 82 and 83, wheel 80 has a slight but significantly advantageous additional feature which is shown in Figure 14. This feature is a flange 104 affixed to one end of the tube 94. The flange also carries a slit 106 to provide access to the interior of the tube. In Figure 14 the flange 104 obscures a dogleg in the slit 96 shaped the same as that at the other end of the tube 94, but the dogleg is evidenced by the angle at which the slit 106 is oriented. The purpose of the flange 104 is explained later in this specification.

As an alternative to having the wheel hub 90 formed from the two discs 92 as shown in Figure 14, the hub may be formed as a single disc of moulded plastics material

about 30 mm thick and having radial bores formed therein to locate the spokes 88. That alternative is more preferred; it would remove the need for insulating segments 89 in the spokes and, by interference fitting the spokes into the hub, remove the need for the rivets 91.

As seen in Figure 13, the rim 86 carries a joiner 108, such as a click-in hose connector, which is easily separated and reconnected in order to provide access for the cable to the slits 102 in the hub. The particular configuration of joiner 108 used is not important. As an alternative to having a joiner in the rim, the wheel may have a continuous slit over the full length of one of the spokes.

Although it would be possible to utilise wheels which have no rim and the spokes bear directly on the ground, the incorporation of a rim means that the wheels have less resistance to rolling and thus the conductor cable maintains a straighter line from the trailer to the fence.

In assembling and operating an electric fence having the above described components, the trailer may be towed into the paddock by a motor vehicle, such as a car, tractor or 4-wheel agbike, and positioned at its starting position facing generally in the right direction. Exact alignment is not necessary as in operation it will find its own way due to the steering mechanism on the front of the trailer.

The towing hitch is disconnected from the vehicle and the front of the trailer lowered onto the dolly wheel 52. The steering shafts 62 and 64 are lowered to a generally horizontal position and the traction cable is run off from the winch 12 and attached to the destination which would usually most conveniently be a fence post.

The conductor cables 30 and 34 are then run out and connected to the fence as appropriate leaving some slack to allow the cables to be slid into the hubs of the cable support wheels 80, 81, 82, etc. The wheels are placed about every 20 to 30 metres along the cable. The two wheels 80 are placed closest the trailer with the flanges 104 towards the trailer. When the wheels are positioned, the conductor cables are

tensioned by their respective winches. A tension in the range of about 30 to 80kg (300 to 800N) has been found to be suitable for conductor cable runs of up to 250 metres.

Since the cables 30 and 34 passing through the axial tubes 94 in the wheel hubs are supported by the tubes, the cable maintains a substantially constant distance above the ground over the long length of the cable and despite the presence of undulating ground. In this way the conductor cable may also pass unhindered over water troughs in the paddock.

The presence of the axial tubes means that the wheels are prevented from falling over while the cable is tensioned because the tubes are forced to maintain an alignment parallel to the ground (because that is the direction being followed by the cable) and the cable is kept at its desired height as set by the radius of the support wheels.

As the cables 30 and 34 are wound in during progress of the trailer over the paddock, it is common for the support wheels 80 closest to the trailer to be drawn in sufficiently to reach the trailer. Conveniently the cables are run from the trailer at a height greater than the radius of the support wheels. In this situation, as the wheels get close to the trailer they cease contact with the ground and become suspended from the cable. This is shown with the wheel on the left side of Figure 15.

Referring further to Figure 15, the arrangement is shown whereby the two conducting cables 30 and 34 travel from winches 8 and 10 respectively across the width of the trailer before passing through guide rollers (not shown) mounted on the opposite side of the trailer. A general layout is shown for some of the components used to maintain the desired tension in cable 30 on winch 8. Although illustrated for winch 8 only, it will be understood that winch 10 also has corresponding components as it acts in the same manner.

While the trailer is being towed behind a vehicle, the steering shafts 62 and 64 are tilted upwards about the pins 66. The wheels used to support the conductor cables are

conveniently carried on the top of the trailer with their axial tube 94 vertical. The tubes 94 are conveniently inserted into the hole 79 in the top of the trailer frame, whereby the sub-frame members 76 and 77 support the wheels 80 to 83 and the tubes 94 of each wheel pass between the spokes of the other wheels. The consequent interengagement of the wheels means they are thus held securely for transport while still being easy to load and unload from the trailer. The traction cable 26 may be stored prethreaded through the guide 70 and conveniently a shackle may be kept attached to the end of the cable 26 to prevent loosening.

The drum of winch 8 has an associated clutch assembly 84 which allows the drum to spin if greater than a preset torque is applied to the winch by its cable. This preset torque is adjustable by the operator and this may be facilitated by using any of the known suitable construction techniques. The drum and clutch are together mounted in bearings, one of which 116 can be seen in Figure 16. The bearings are, in turn, mounted on a support table 118 which is able to pivot about pins 120 journalled in a pair of clevises 13 welded to the base 72 of the trailer frame.

Looping over each of the conductor winch assemblies 8 is a winch frame member 122 which extends between the two winch bearings 116. Welded to the frame member 122 is a clevis 123 which carries a pin 125 with a diametrical hole 127 through it. Extending across the trailer to above the winch is a round steel bar 124. One end of the bar 124 is threaded and fixed to the trailer frame on the far side of the trailer. The other end of the bar 124 is also threaded and passes through the hole 127 in the clevis pin 125. A lock nut 129 on the end of the bar 124 retains the bar through the clevis pin. A collar 126 is firmly welded to the bar 124 and a compression spring 128 wound around the bar is firmly held between the clevis pin 125 and the collar 126.

As the tension in cable 30 increases, such as when the trailer moves forward at a time when the cable 30 should be played out from the winch, the whole of winch, electric motor, bearings and table 118 pivot about pin 120 towards the left of Figure 16 while the clevis pin 125 slides leftwards along the bar 124. This movement is resisted by the spring 128. Thus for any given tension in the cable 30 the winch will pivot to the

position which gives a balancing compression of the spring. When the spring is compressed sufficiently that the preset torque on the winch is exceeded, the clutch slips, the winch drum spins and the cable is let out under a generally constant tension controlled by the clutch.

A roller-tipped micro-switch 130, with its body attached to the trailer frame and its actuation arm biased against the bearing housing, provides a signal when the winch is sufficiently tilted towards the right in Figure 16 and therefore needs to wind in the cable. The mechanism in switch 130 is such that it turns on when the lever is significantly further to the right in Figure 16 than when it turns off. Use of such a differential switch prevents "hunting" around a single control setting. The winch with its pivoted, spring loaded mounting and its clutched play-out and differentially switched wind-in offers considerable advantages. If cattle push against a conductor cable held across the paddock, in a bid to reach almost accessible fresh feed, the first outgoing movement of the cable is taken up by compression of the spring 128 and then by slipping of the clutch. As soon as the animal stops pushing, the cable slackens, the switch turns on and the winch winds in the slack.

An alternative arrangement is shown in Figure 17. In this, instead of using a clevis arrangement, the bar 124 extends across the trailer and is held firmly to the trailer frame by nuts at each end. Connected to the top of the bearing 116 is a plate 121 having a vertical slot through which the bar 124 passes. A collar 126 is firmly welded to the bar and a compression spring 128 is held between the plate 122 and the collar.

Figure 18 is a view looking from outside the trailer at the guide roller assembly where the conductor cable 34 leaves the trailer. The guide rollers are in a relatively standard configuration of two horizontal rollers 132 on the inside with two vertical rollers 133 on the outside heavily overlapping the horizontal rollers. This arrangement is commonly referred to as a fair-lead. The cable passing through the assembly is therefore easily controlled and run across the trailer to winch 10.

Figures 19 and 20 are views showing different positions relative to the guide roller assembly as the trailer moves past the point of minimum cable length. The trailer is moving in the direction to the left in Figures 19 and 20 and the position in Figure 19 comes before that in Figure 20. As discussed above with reference to Figure 15, the cable support wheels will often be drawn to the trailer as it shortens a conductor cable. When close to the trailer, a wheel will leave the ground to be suspended by the cable 30. The flange 104 prevents the axial tube 94 from getting jammed in the roller assembly, but this of course is applicable to only the wheel 80 closest the trailer because subsequent wheels will bear flange 104 to flange 104.

Furthermore a capture and release mechanism ensures the wheel is retained for an appropriate time so that a proper spacing of support wheels is achieved. As the flange 104 approaches the roller assembly it first bears against a rib 135. At this stage the cable is being taken up so friction between the cable and tube 94 tend to pull the flange 104 towards the frame. As the trailer passes the point where cable 34 starts to be fed out from the winch, the cable moves across to the rear vertical roller and the flange 104 slips into the metal hoop of the catcher component 137. This is pivoted at 138 and has an over-centre spring device associated with it so that it keeps pivoting gradually as the tube 94 pushes it further and further backwards until the over-centre mechanism actuates quickly flipping the catcher back away from the flange and allowing the wheel to go out with the cable.

As shown in Figure 5, a row of holes 85 extends down each vertical sub frame member 75. These holes are provided to allow attachment of the fair-lead and catcher 137 assemblies to the trailer body at the appropriate height to suit the radius of the wheels 80 being used, which radius is in turn governed by the particular livestock being controlled.

The trailer 2 is constructed with a manually actuated braking system which is sufficient to prevent it rolling forwards. For a trailer in the position shown in Figure 7, a tension of say 500N maintained in each of the conductor cables 30 and 34, would give a resultant of about 600N urging the trailer forwards. The brake provides

appropriate resistance to consequent forward motion and is particularly relevant on gentle downhill slopes. After the trailer has passed the mid-point 38 as shown on Figure 7, the resultant force on the trailer from the tension in the conductor cables tends to pull it backwards although this is readily counteracted by the traction cable 26. Accordingly the brake is not required after the mid point, so at or soon after the mid point the brake is preferably deactivated.

In the embodiment of the invention shown in Figure 2 the braking is achieved by using an automobile transmission differential 14 as the axle and attaching, at the central "input shaft" an external faced friction drum 16 which is engaged by a friction belt tensioned by a manually actuated lever (not shown) which moves vertically and is latched into position to provide the required amount of braking effect. The horizontally acting latch has an extension 140 which can be seen in Figures 18 to 21. The latch extension 140 is pushed forwards by cable 34 as it moves from its position in Figure 19 to its position in Figure 20 and this movement of the latch disengages the lever applying the brake.

As an alternative to the above described braking system utilising a an automobile transmission differential, the trailer may be provided with drum brakes at each wheel 6 as used on a conventional light duty trailer for a motor car. An actuating cable from the brakes may be connected to a manually actuated lever and release trigger mechanisms in a similar manner to the actuating and release latch 140 described earlier in this specification.

Although the above described braking system is relatively simple in operation and adjustment, it does introduce a disadvantage that typically, in the first stages of travel across a paddock, the traction winch needs to overcome the resistance of the brakes. But the degree of resistance required from the brakes is affected by the tension in the conductor cables when the trailer is stationary. A method of reducing the tension in the conductor cables when the trailer is stationary is to utilise a more complex electrical control strategy for the conductor winches 8 and 10. An example would be to use a reverse polarity and reverse switching strategy. To achieve this, instead of

the conductor winch motor switching off when the set maximum tension is reached, the switch concerned instead reverses the polarity of the voltage to the winch motor, so driving the motor backwards and reducing the tension in the conductor cable, until the lower set tension is achieved whereupon the switch turns off further winch motor activity until required.

During operation of the electric fence described substantially all of the trailer body carries the fence voltage. This helps to keep animals from interfering with operation of the trailer. It is therefore important that the trailer body is not allowed to earth. It has been found that automobile type tyres on wheels 6 provide sufficient electrical insulation, but the traction cable 26 laying on the ground would provide an excellent earthing path. Therefore the axle 54 is mounted to the A-frame 5 by way of an insulating bush 55 and washer 57 made of plastics material. The bush 55 surrounds the axle 54 and has a flange 53 on its upper end to prevent electrical contact between the base plate 56 and the A-frame 5. So although the short A-frame 5 is electrically live, the base plate 56, axle 54, dolly wheel 52, front winch 12, cable 26 and controls housing 15 are not subject to the electric fence voltage.

The switches and other controls for operating the apparatus may be placed in any easily accessible place on the trailer. As shown in Figures 2 and 3 they are preferably contained in a waterproof housing 15 mounted on the base plate 56 over the A-frame draw bar 5 where it would be protected from livestock when the apparatus is in use. So that the rate of advancement of the trailer may be conveniently adjusted by the operator while the equipment is operating, and thus the frame 4 is electrically live at the electric fence voltage, the controls housing 15 is electrically insulated from the trailer frame.

With reference to Figures 22, 23 and 24 which show the leading tip of the trailer, arms 62 and 64 are welded together where they join and longitudinally beneath them is welded a short section of square hollow tube to form a switch frame 144. Onto the top of this frame is mounted a micro-switch 146 and this is set down in between the shafts 62 and 64 for protection. Passing through the switch frame 144 is a slightly

smaller square hollow tube 148 with a clearance fit between the two tubes. The tube section 148 acts as a plunger shaft. At one end of shaft 148 is welded a vertically upstanding contact plate 150 while at the other end of the shaft is attached the cable guide 70. In Figure 23 the cable guide is shown in section and the shaft 62 has been removed for clarity.

A spring arrangement within the switch frame 144 biases the contact plate 150 against the rear end 152 of the switch frame. In this position the contact button 154 on the switch 146 is depressed sufficiently to have the switch in the on position. When the cable guide 70 is pushed rearwards, the tube 148 slides within the switch frame 144, the contact plate 150 moves back from the rear end 152 of the switch frame so losing contact with the contact button 154, and the switch is thus moved to the off position. In Figures 22 and 23 the guide 70 is shown slightly depressed so the contact plate is clear of the switch.

When this switch is wired in series with the timer switch for the traction winch 12, the trailer will not be moved forward when the guide 70 is pushing against anything such as the fence post to which it is headed. This switching mechanism may also be triggered by clamping an object to a desired position on the traction cable 26 so that when the guide 70 reaches and presses against it the trailer ceases further forward motion.

The guide 70 comprises an upper plate 156 and lower plate 158 approximately 10cm long and 2cm wide separated by a spacer 160 at each end with the plates and spacers held together with two screws and nuts 160. The upper plate 156 is welded to the front tip of the shaft 148. The traction cable 26 passes between the plates. The spacers 160 may be made of a toughened polyurethane material to reduce wear upon the traction cable.

Preferably the portion of shaft 148 extending beyond the front of the frame 144 is significantly longer than as illustrated in Figure 23. This provides a longer distance for the trailer to stop between actuation of the switch and an abrupt stop caused by the

top plate 156 striking the switch frame 144. An appropriate choice of spring linking within the switch frame 144 provides adequate gentle deceleration of the trailer when the cable guide 70 is brought to an abrupt stop by striking something.

It will be appreciated that if the fence electrification is generated on the trailer, rather than sourced from a fixed supply at the paddock fence, a sound earth connection must be made from the trailer. This is most conveniently done via the traction cable which may be positively earthed at its free end or may be earthed by it simply lying on the ground. The fence electrification may be generated on board the trailer by use of solar cells. Solar cells may also be utilised to top up the battery powering the winches.

Referring to Figure 25, another embodiment of the invention has two trailers 180 and 182 in a generally square paddock having corners 176, 177, 178 and 179. Each trailer is being pulled forward by traction cables 184 and 186 respectively. The trailers 180 and 182 travel adjacent to side fences 188 and 190. Trailer 182 has only one conductor cable 192 which is run out from a winch 194 and kept tensioned in the manner described above with reference to Figures 15 and 16. The end of cable 192 is connected to trailer 180 and is supported by cable support wheels 196 to 199 of the type described with reference to Figures 12 to 14. Trailer 180 carries no winches for conductor cables. Spring loaded electrified arms (not shown) protrude from the fence side of each trailer to rub against the adjacent fence and so prevent stock from pushing between the trailer and the fence. The traction winches on each trailer may be operated concurrently or one traction cable may be fully wound in before commencing to move the other trailer.

The embodiment described with reference to Figure 25 has the advantage of requiring only one of the tension actuated winches, but has the disadvantage of requiring two trailers, two traction winches and the side arms extending to the fences 188 and 190.

Whilst the above descriptions include the preferred embodiments of the invention, it is to be understood that many variations, alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously

described without departing from the essential features or the spirit or ambit of the invention.

For example, the preferred embodiments described all utilise a cable being wound onto a drum winch as the means of propelling the carriage means over a paddock. As an alternative, the traction cable may be left out on the ground in the paddock concerned and a capstan winch fitted to the trailer to engage the traction cable. The carriage means may alternatively use a motor drive to a ground engaging wheel (or wheels) to propel itself.

It will be also understood that where the word "comprise", and variations such as "comprises" and "comprising", are used in this specification, unless the context requires otherwise such use is intended to imply the inclusion of a stated feature or features but is not to be taken as excluding the presence of other feature or features.

Claims

1. An electric fence assembly comprising:
   (i) a carriage means which moves across the ground inside a fenced enclosure;
   (ii) an electrically conducting element extending from the carriage means to an anchorage point at a fence of the enclosure;
   (iii) means for supporting the conducting element above the ground between the carriage means and the anchorage point;
   (iv) means for maintaining the conducting element at a voltage suitable for an electric fence; and
   (v) means for propelling the carriage means across the ground.

2. An electric fence assembly according to claim 1 wherein the propulsion means comprises a motor powered winch mounted on the carriage means and the winch engages a cable.

3. An electric fence assembly according to claim 2 wherein the propulsion means further includes a cable fully windable onto a drum of the winch.

4. An electric fence assembly according to claim 1 wherein the propulsion means comprises a capstan winch mounted on the carriage means.

5. An electric fence assembly according to claim 1 wherein the carriage means includes a steerable wheel which engages the ground to steer the carriage means, and a steering mechanism which engages the cable and points the steerable wheel towards the destination

6. An electric fence assembly according to claim 5 wherein the steering mechanism comprises a steering control member extendable in front of the steerable wheel and the steering control member includes means for turning off or disengaging the propulsion means when the steering control member hits an obstacle.

7. An electric fence assembly according to claim 1 including means for winding in and letting out the electrically conducting element in order to keep the conducting element tensioned between selected tension limits.

8. An electric fence assembly according to claim 1 wherein said means for supporting the conducting element above the ground includes wheels with the conducting element extending axially through the wheels.

9. An electric fence assembly according to claim 8 wherein tension applied to the conducting element causes the wheels to stand generally vertically and at right angles to the conducting element.

10. An electric fence assembly according to claim 8 wherein each said wheel includes a tube passing through the wheel's axis of rotation and the conducting element passes through the tube.

11. A method of allowing access by livestock to fresh feed in a fenced enclosure comprising:

(i) partitioning the enclosure by an electric fence assembly so that the livestock may graze in a first portion of the enclosure but are excluded from a second portion containing said fresh feed;

(ii) causing the fence assembly to move so that it advances across said second portion of the enclosure to expose more feed to the livestock.

12. A method according to claim 11 wherein the fence assembly periodically advances across said second portion of the enclosure.

13. A method according to claim 12 wherein said means to cause the fence assembly to advance the propulsion means comprises a a winch which winds in a cable intermittently.

14. A method according to claim 11 wherein the fence assembly moves under its own propulsion.

15. A support for an electric fence, said fence comprising a conducting element held above the ground at a height suitable for the relevant livestock, said support comprising a wheel having a circumferential rim with a diameter of twice the height at which the horizontal conducting element is held above the ground, and the conducting element passing through a hollow axis member of the wheel.

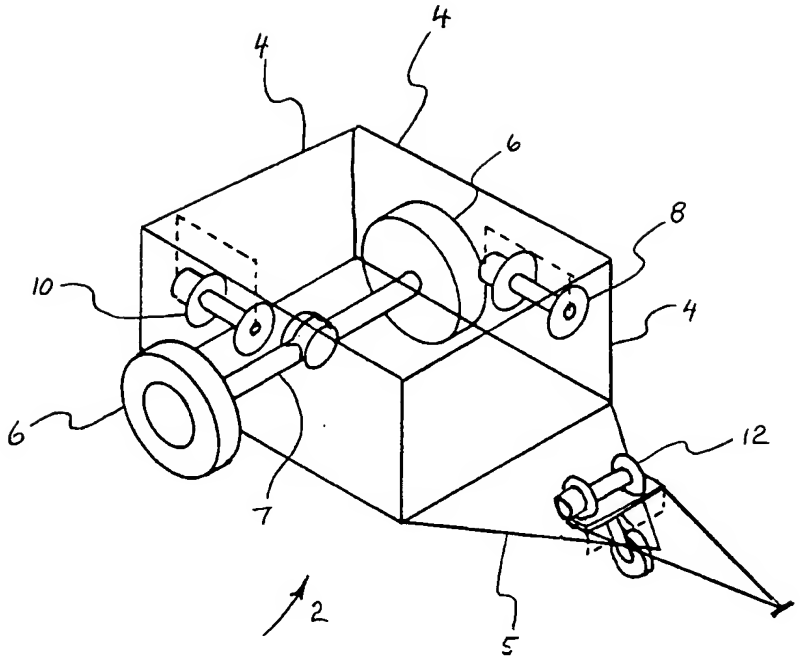

Fig. 1

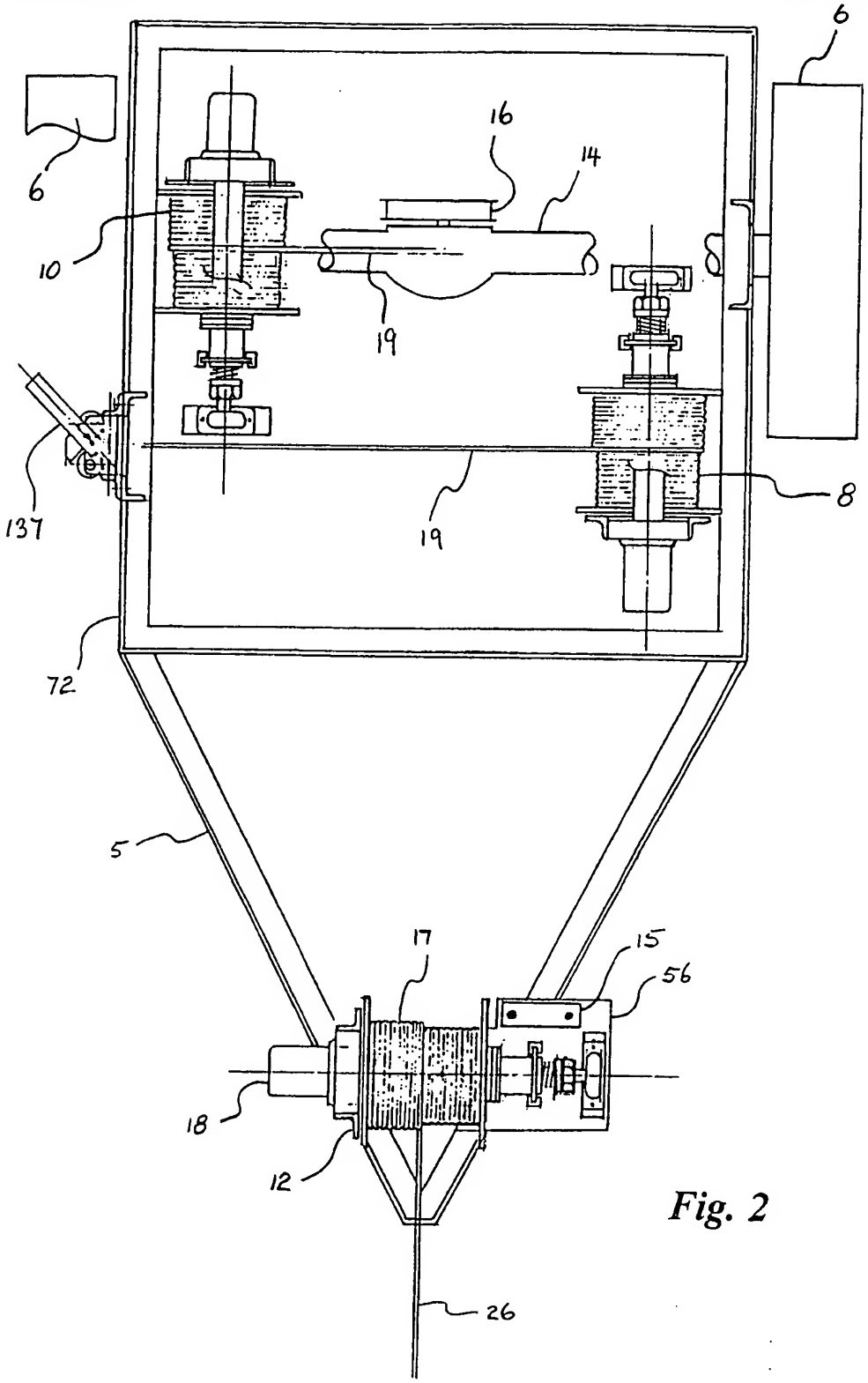

Fig. 2

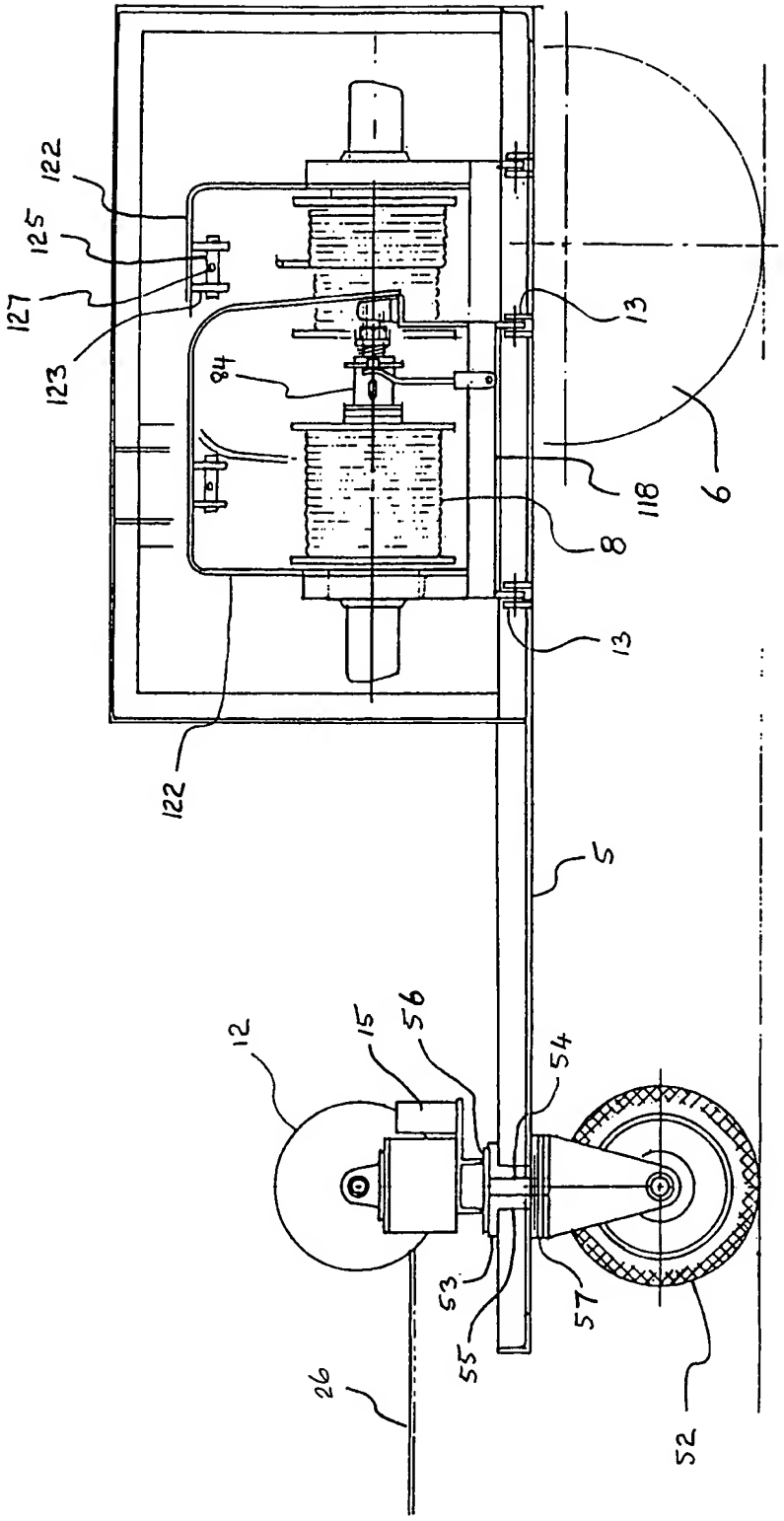

Fig. 3

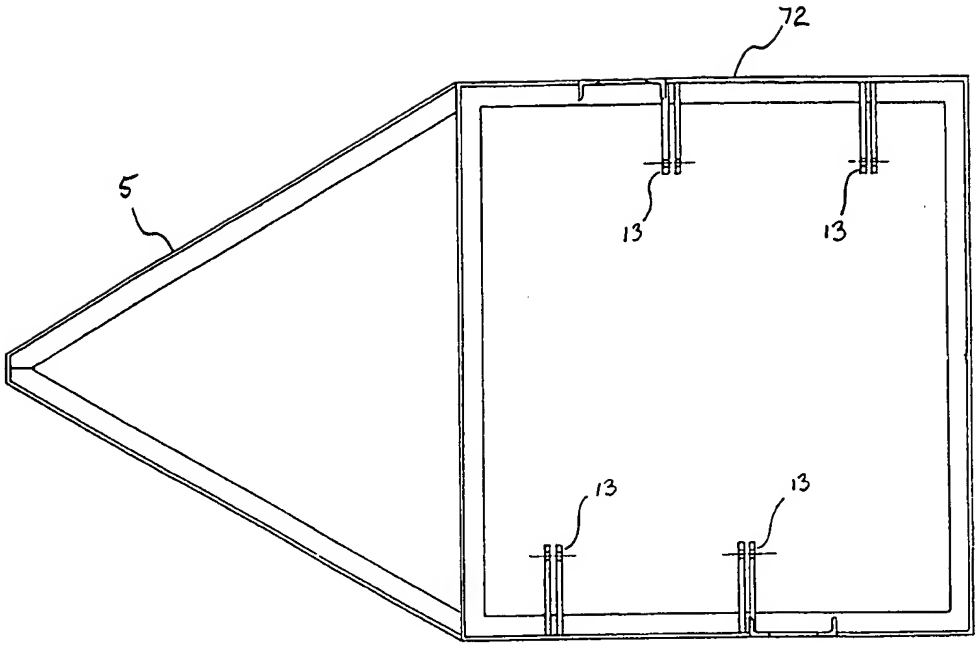

Fig. 4

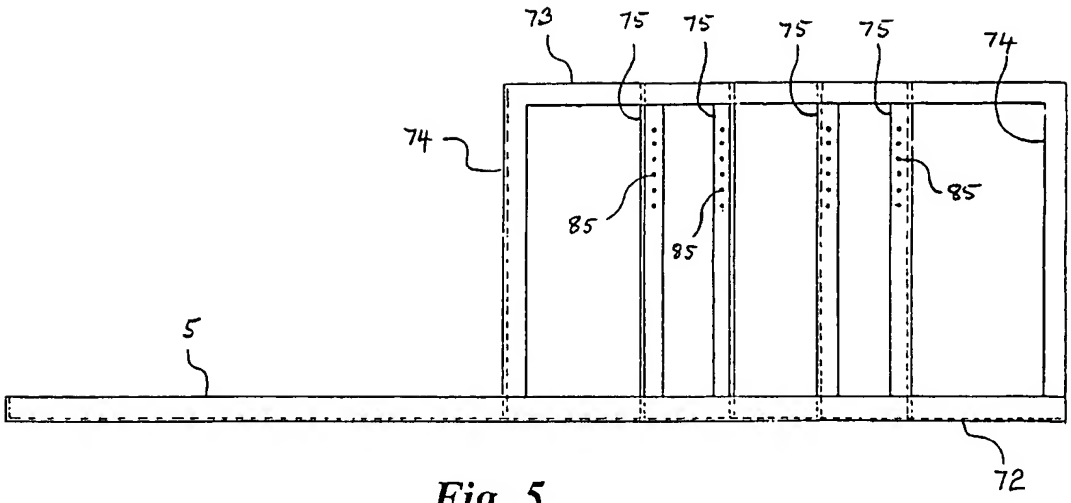

Fig. 5

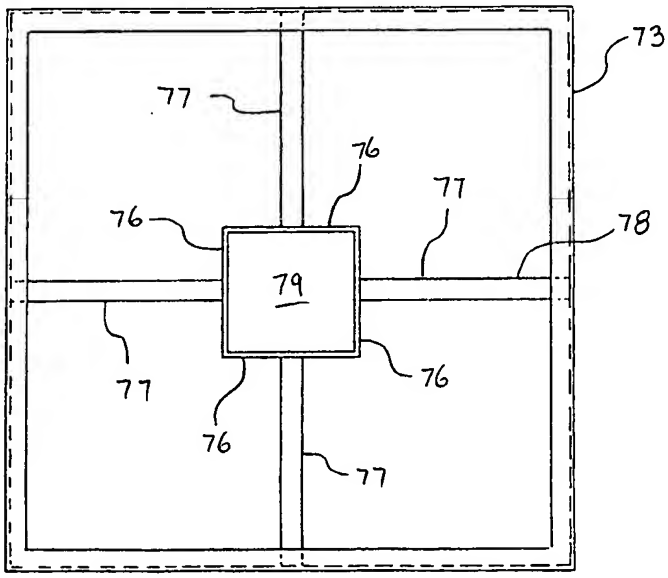

Fig. 6

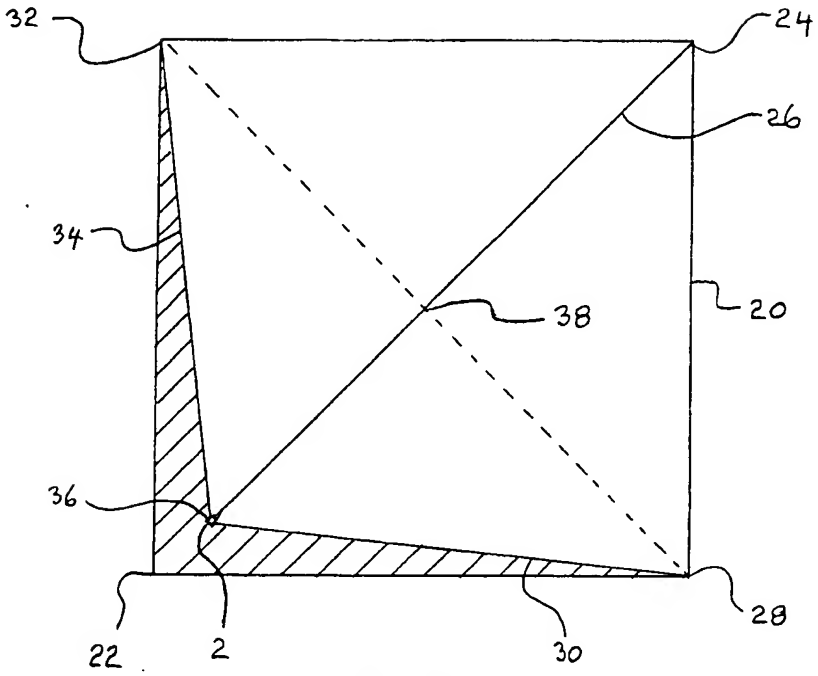

Fig. 7

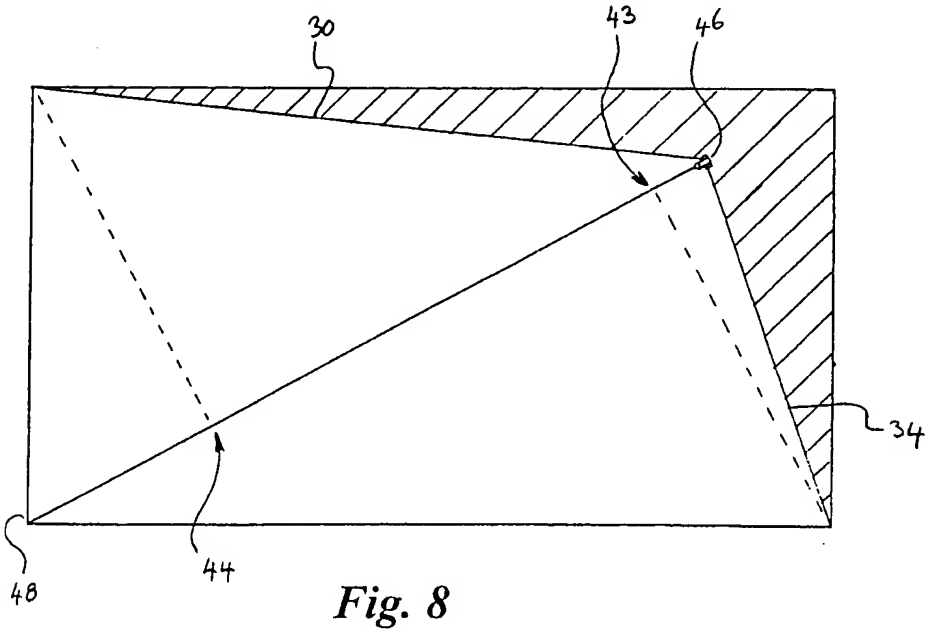

Fig. 8

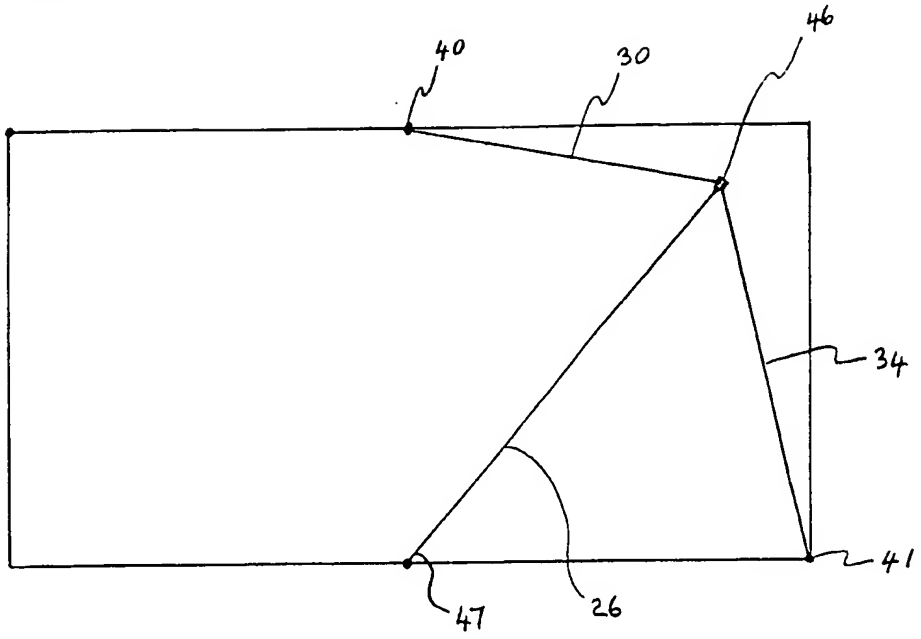

Fig. 9

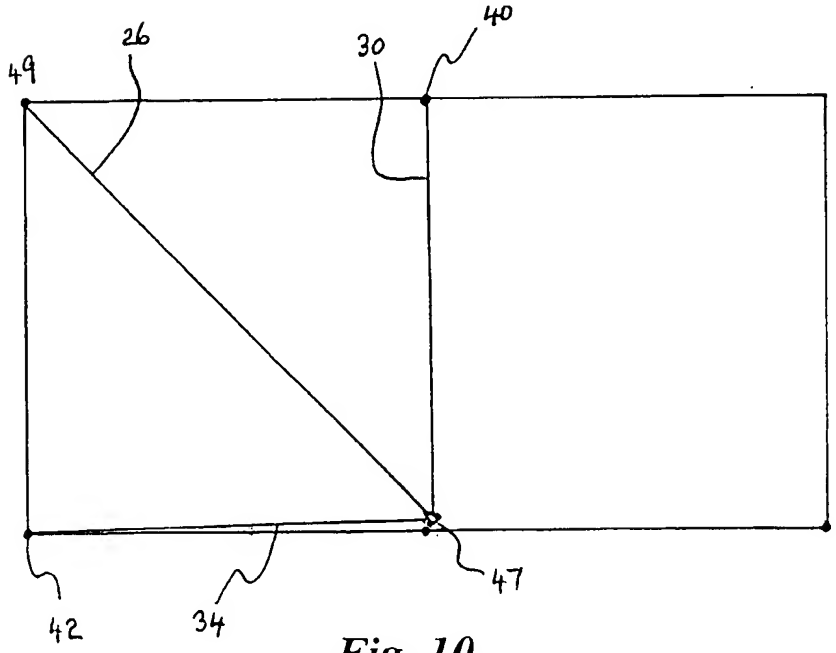

Fig. 10

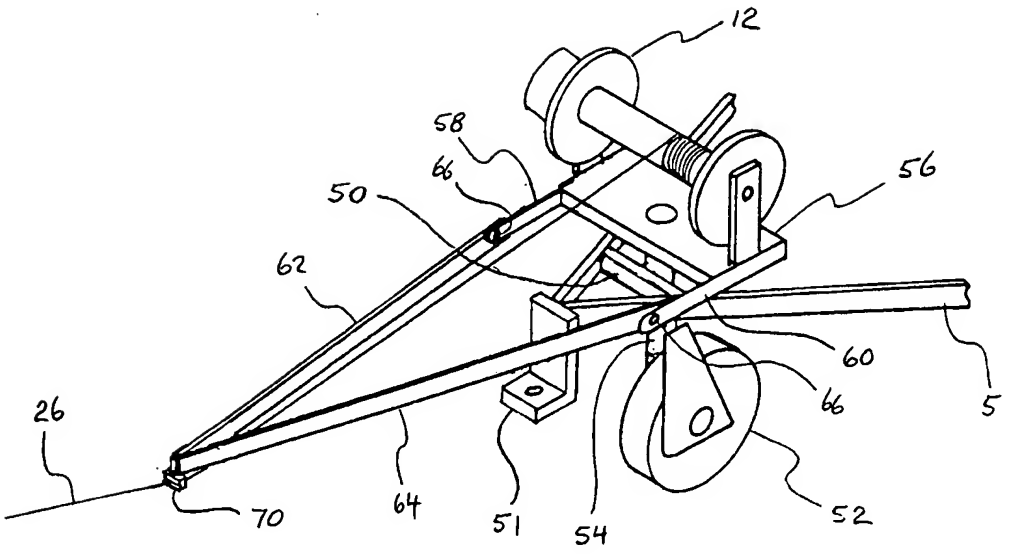

Fig. 11

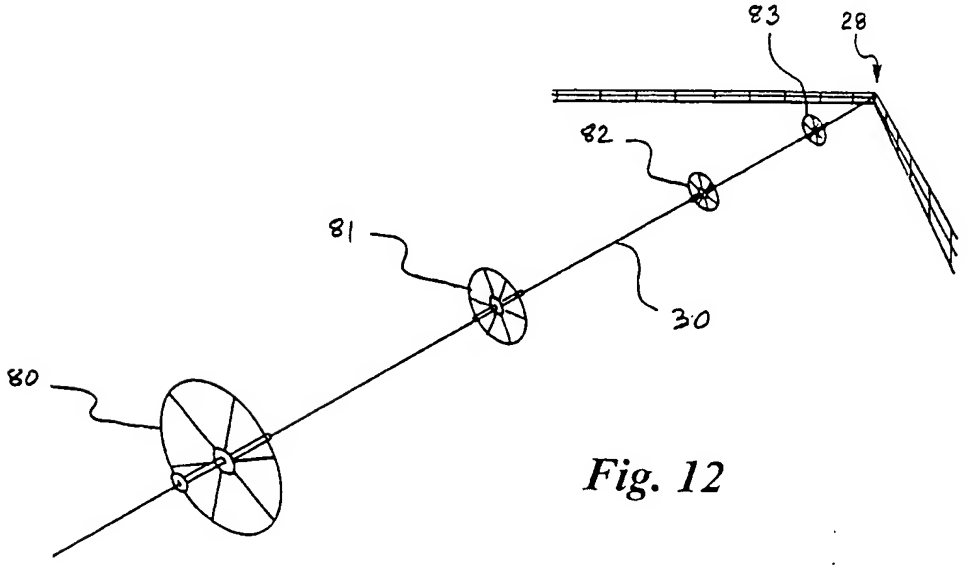

Fig. 12

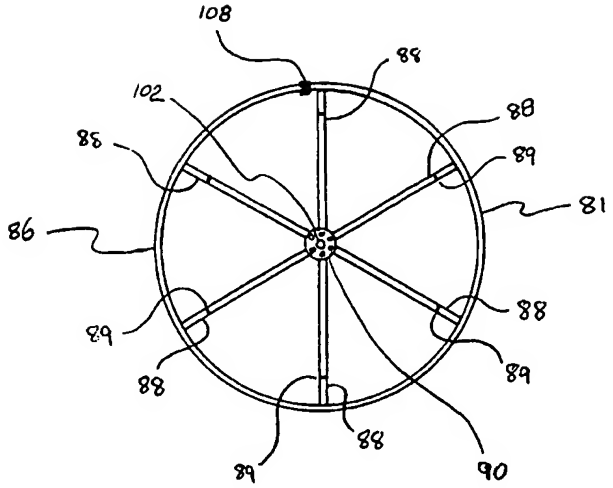
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Fig. 13

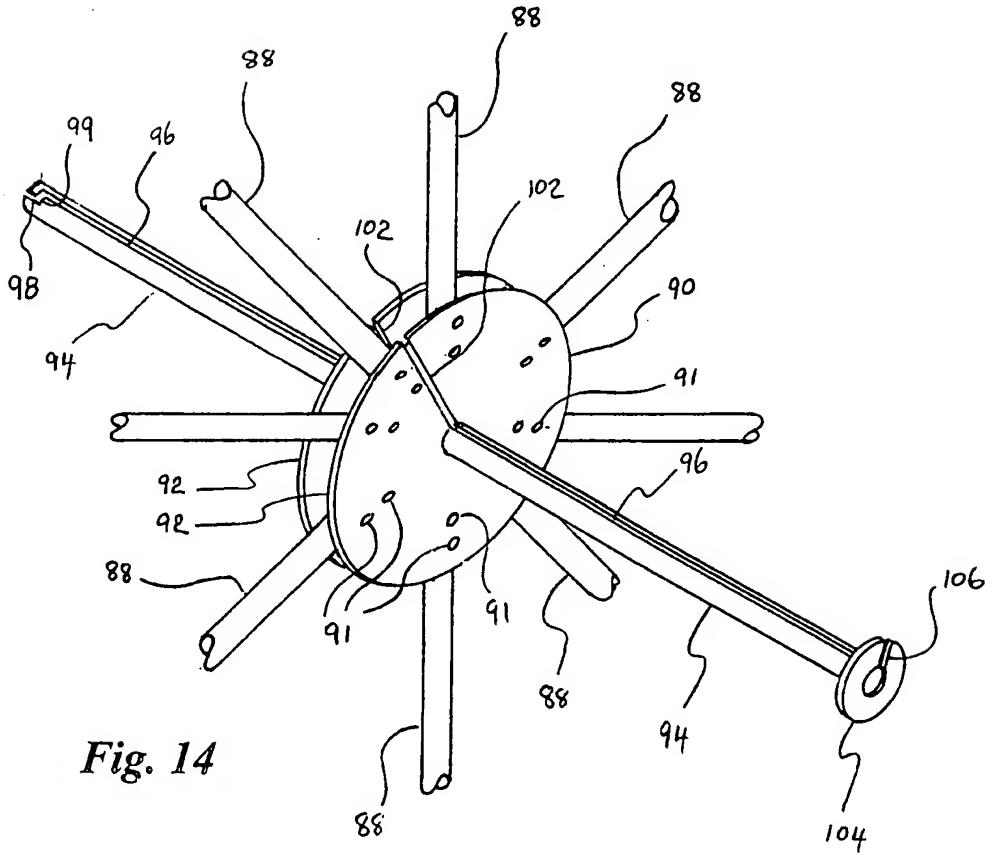
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Fig. 14

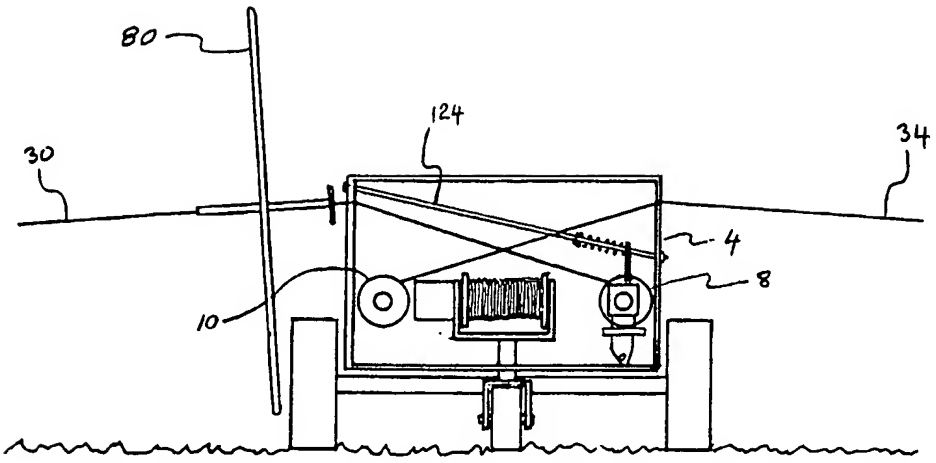

Fig. 15

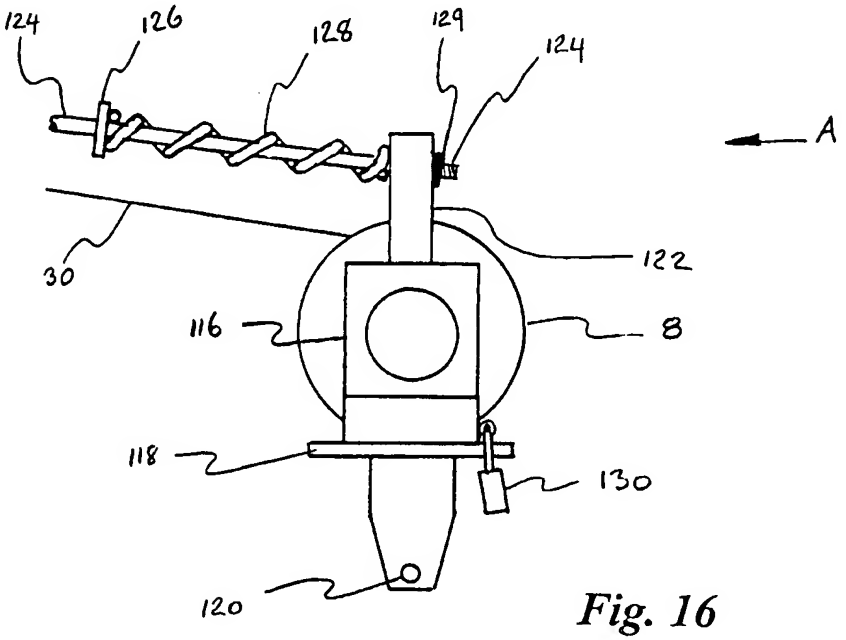

Fig. 16

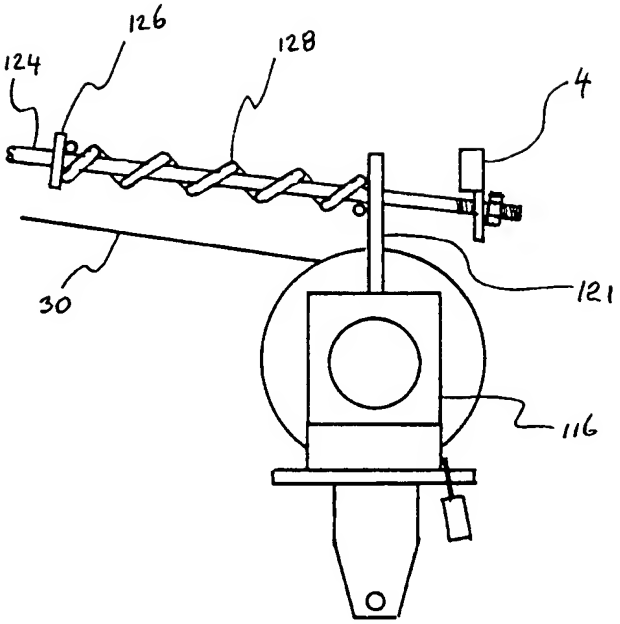

Fig. 17

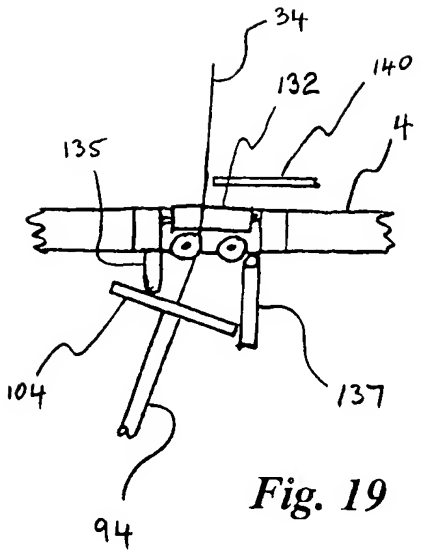

Fig. 19

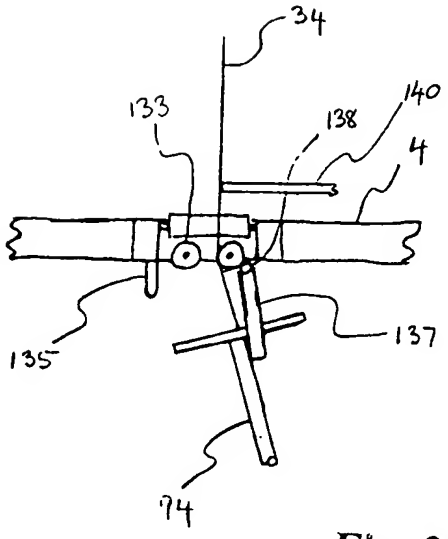

Fig. 20

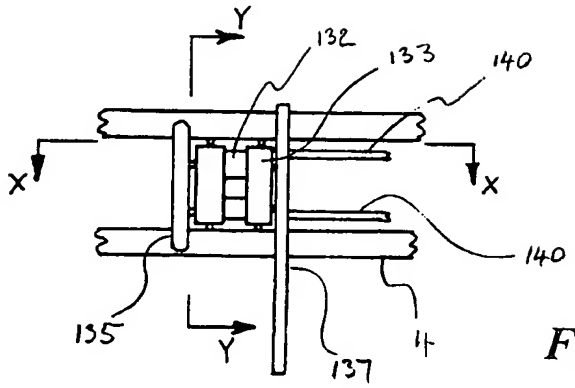

Fig. 18

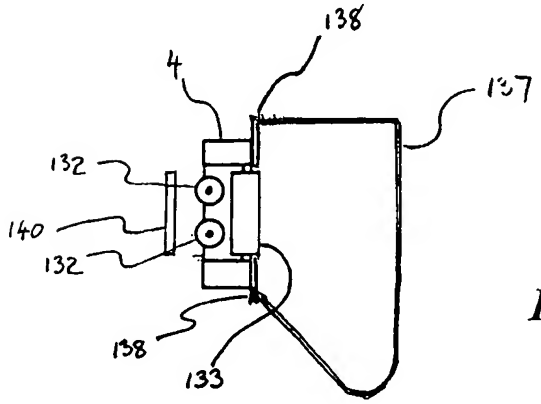

Fig. 21

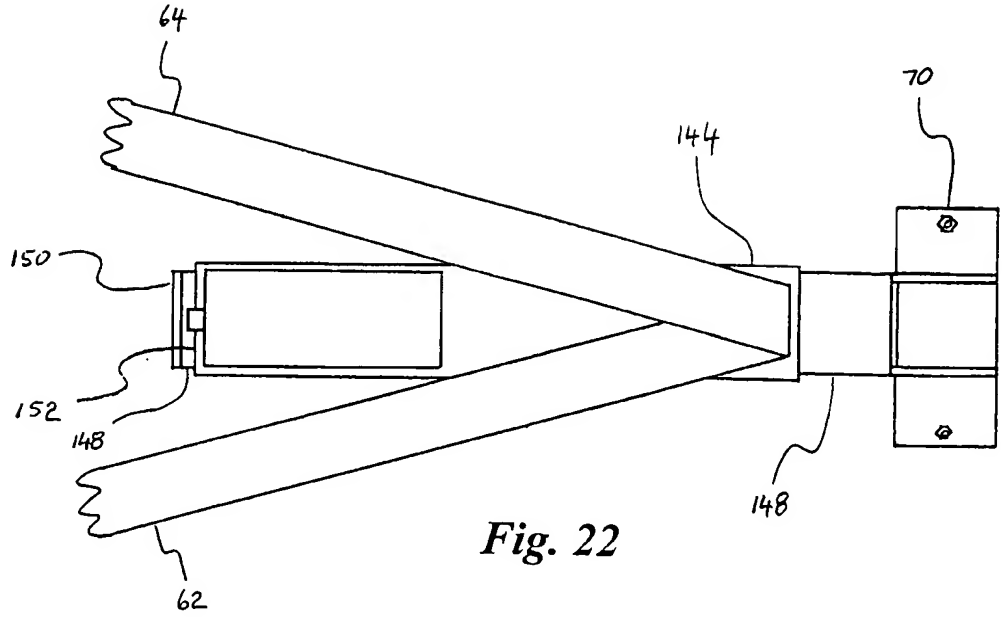

Fig. 22

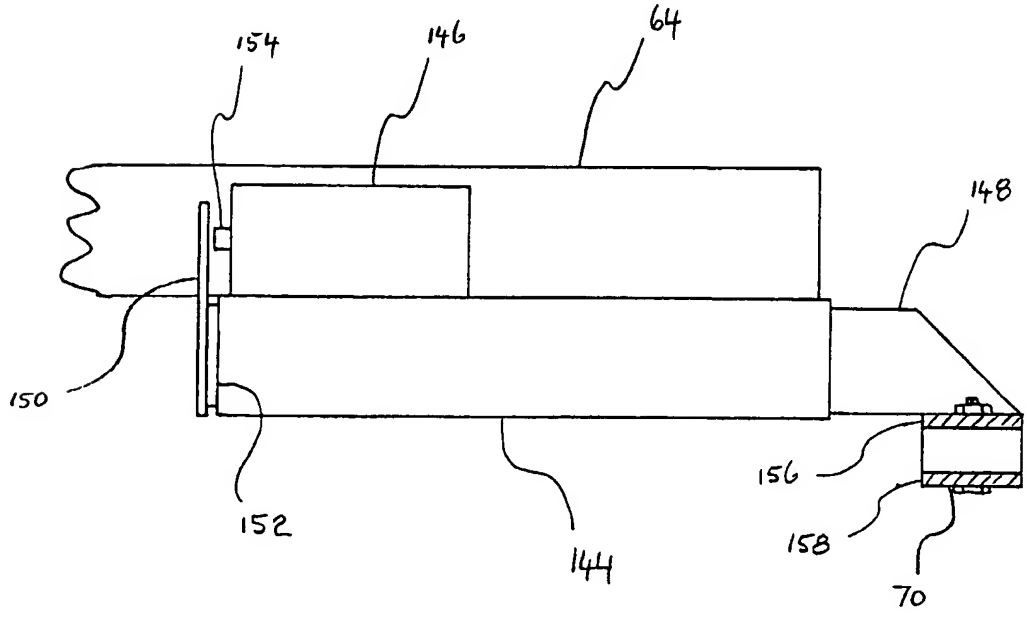

Fig. 23

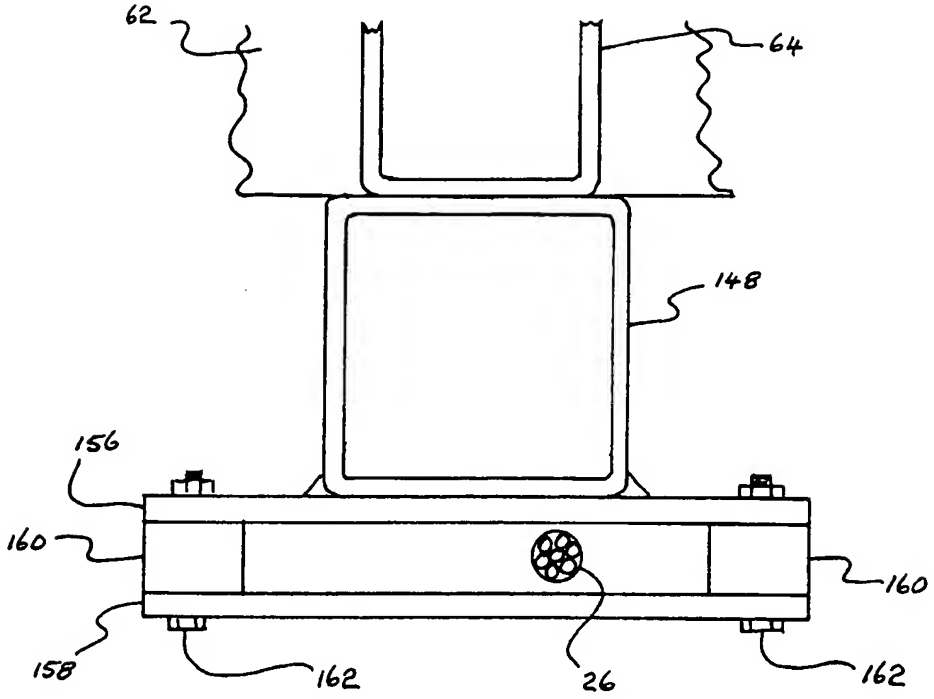
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Fig. 24

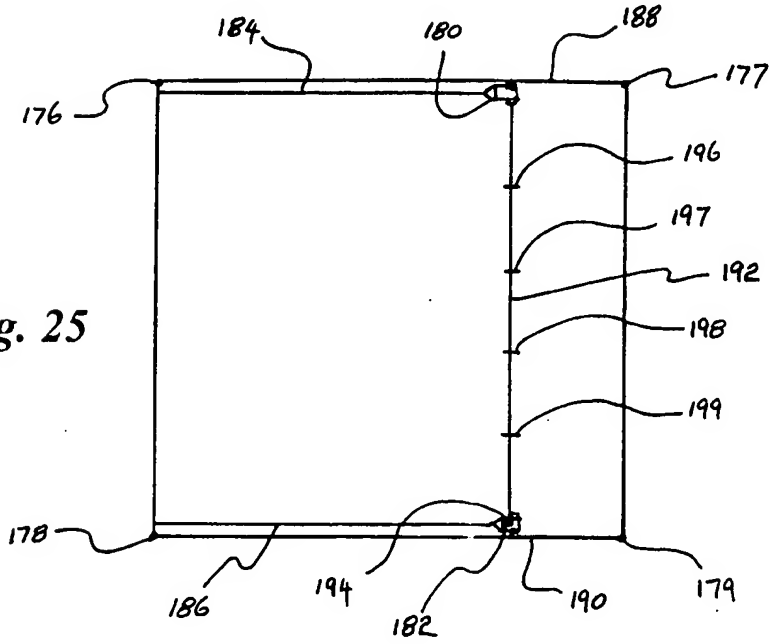
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Fig. 25

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00910

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: A01K 3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: A01K 3/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC AS ABOVE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DERWENT
US DATABASE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	US 6062165 A (SIELING) 16 May 2000 Entire document	1-14
X	US 4078771 A (DIGGS) 14 March 1978 Entire document	1-15
X	DE 3245152 A (SCHELLER) 7 June 1984 Entire document	1-4, 7, 11-13

[X] Further documents are listed in the continuation of Box C [ ] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 August 2000	31 AUG 2000
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer A SEN Telephone No : (02) 6283 2158

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00910

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 4215714 A (SCHULTE) 18 November 1993 Entire document	1-14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00910

Box I **Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :

because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos :

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos :

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II **Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

Please refer to the Supplemental Box

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00910

Supplemental Box
(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1 to 10 are directed to a carriage means for moving an electric fence assembly within a fenced enclosure with an electrically conducting element extending from an anchorage point on the fence, a means for supporting the conducting element, a means for maintaining a voltage in the conductor and a means for propelling the carriage means. It is considered that the movable fence assembly with an anchored electric conductor comprises a first "special technical feature".

2. Claims 11 to 14 are directed to a method of controlling access of livestock by partitioning a fenced enclosure with an electric fence assembly and moving the electric fence assembly across the fenced enclosure It is considered that moving the electric fence assembly across the fenced enclosure comprises a second "special technical feature".

3. Claim 15 is directed to a support for a conducting element of an electric fence. It is considered that a wheel with a hollow axis member comprises a second "special technical feature".

The first two groups of claims are not so linked as to form a single general inventive concept, that is, they do not have any common inventive features, which define a contribution over the prior art. The common concept linking together these groups of claims is a moving electric fence assembly However this concept is not novel in the light of the documents cited in this search report. Therefore these claims lack unity a posteriori.

The three groups of claims taken together do not share any of the technical features identified, and therefore a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept, a priori.